State of Wisconsin

2004

Zion

Environmental Radioactivity Survey

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Introduction

Wisconsin Public Health Statues 254.41 mandates the Department of Health and Family Services to conduct environmental radiation monitoring around the nuclear power facilities that impact Wisconsin. This environmental monitoring report is for the Zion nuclear generating plant for the calendar year January - December 2003 and provides a description and results of this environmental monitoring program.

WI DHFS Zion Environmental Monitoring Sampling Program

The WI DHFS environmental monitoring program consists of the collection of various types of samples from the air, water and terrestrial exposure pathways. The sampling program included samples of air, ambient gamma radiation (TLD), surface water, soil and vegetation that are collected from selected locations at planned sampling intervals.

Table 1 is a listing of presently used sampling sites that have been renumbered after eliminating sample sites that have been discontinued. Sampling sites that have been discontinued were last listed as sampling sites in WI DHFS's environmental monitoring report for the Zion nuclear plant for the calendar year of January - December, 2000. Table 2 provides a listing of types of samples collected, collection frequency, sites where samples are collected, the number of samples collected, number of samples that were missed and a listing of the required analyses. Table 3 provides an explanation of missing samples or non-routine sample analyses. Figure 1 is a map showing the location of each environmental sampling site.

Program Modifications

In January 1998 ComEd announced that it was permanently closing the Zion nuclear power station and initiated the process of decommissioning the Zion station. In response to this and due to other funding restrictions, the Zion environmental monitoring program was reviewed and modified in 1998 and 2000.

There were no additional program modifications for 2004.

Laboratory Services and Quality Assurance

The analysis of the samples is performed under contract with the State Laboratory of Hygiene (SLH). SLH maintains their own quality assurance program. Analytical procedures provide for routine replicate analyses to verify methods and instrument operation. Traceable sources are used to regularly calibrate the counters and daily performance checks are made between calibrations. In addition, quality control charts are maintained on the counters.

SLH participates in the Environmental Resource Associates' Proficiency Testing program and has performed satisfactorily over the report period. Proficiency testing results are available from the State Laboratory of Hygiene.

Detection Limits

Detection limits, required by WI DHFS, will be expressed as a lower limit of detection (LLD). The required WI DHFS LLD as indicated in Table 4 under the heading "LLD" is an "a priori" estimate of the capability for detecting an activity concentration by a given measurement system, procedure, and type

of sample. Counting statistics of the appropriate instrument background are used to compute the LLD for each specific analysis. Using 4.66 times the standard deviation (s_b) of the instrument background, the LLD for each specific analysis is defined at the 95% Confidence Level.

The LLD for each radioisotope listed in Table 4 has been calculated from the following equation:

$$LLD = \frac{4.66\ s_b}{E * V * 2.22 * Y * S * \exp(-dt)}$$

Where:

LLD	is the "a priori" lower limit of detection as defined above, as picocuries per unit mass or volume,
s_b	is the standard deviation of the background counting rate or of the counting rate of blank sample as appropriate, as counts per minute,
E	is the counting efficiency, as counts per disintegration,
V	is the sample size in units of mass or volume,
2.22	is the number of disintegrations per minute per picocurie,
Y	is the fractional radiochemical yield, when applicable,
S	is the self-absorption correction factor,
d	is the radioactive decay constant for the particular radionuclide, and
t	for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting.

Typical values for E, V, Y and dt have been used to calculate the LLD.

Reporting of Sample Analysis Results

Results for specific analyses will be reported as either a “less than” (<) value or an actual activity value. The reporting of results in Table 4 under the heading “Range” and in Tables 5-9 is “a posteriori” calculation based on the actual analysis performed using the actual sample values for E, V, Y and dt. Typically the reported “less than” (<) results are lower than the required WI DHFS LLD indicating that the required WI DHFS LLD has been met.

In late March and early April, SLH was in the process of upgrading from one software vendor to another for the qualitative and quantitative analysis of environmental samples. As a result some reported “less than” numbers for some analyses did not meet the required WI DHFS LLD. These reporting deviations have been indicated in Table 3.

An actual activity value will be accompanied by an uncertainty term for that analysis. The uncertainty term is a plus or minus counting uncertainty term at the 2 sigma (95%) confidence interval and is printed as (+- or $\pm$). Examples and explanations of data reporting are:

Example	Nuclide	Activity reported
1	^{137}Cs	< 10 pCi/liter
2	^{137}Cs	15 $\pm$ 3 pCi/liter

In example 1 we can be 95% confident that the sample activity, if any, is less than the MDC of 10 pCi/liter. In example 2 we can be 95% confident that the actual sample activity is greater than the MDC for that analysis and is between 12 and 18 pCi/liter.

Table 1. WI DHFS Zion environmental monitoring sampling sites.

Sample site	Distance and direction (miles)	Location description
ZI-1	3.8 N	Chiwaukee Prairie.
ZI-2	8.5 NW	Pleasant Prairie, Roger Prange Municipal Center
ZI-3	10.0 N	Water intake - 4700 feet from shore.
ZI-4	5.9 NW	Junction of Highway 31 and County ML.
ZI-T41	4.7 NW	Junction of 122th Street and 39th Avenue
ZI-T42	3.8 N	Chiwaukee Prairie.
ZI-T43	10.1 N	Kenosha Water Utility

Table 2. Sample collection summary and required analyses for 2004.

Sample Type	Collection and Frequency	Site locations	Number of Samples Collected	Number of Samples Missed	Required Analyses
Air Particulate	C/BW	1,2	45	9	GA, GB, GI
TLD	C/Q	T41 - T43	12	0	direct exposure
Surface Water	G/SA	3	3	0	GA, GB, Sr, H
Vegetation	G/SA	1, 4	4	0	GA, GB, GI
Soil	G/SA	1, 4	4	0	GA, GB, GI

Collection type: C/ = continuous; G/ = grab

Frequency: /W = weekly; /M = monthly; /Q = quarterly; /A = annually; /BW = bi-weekly; /SA = semi-annually

Required analyses: GA = gross alpha; GB = gross beta; GI = gamma isotopic; Sr = strontium; H = tritium

Table 3. Missing sample report for 2004.

Sample type	Date	Site	Explanation
Air Particulate	01/22/04	ZI-2	Due to air site electrical problems, gross beta data was not available for approximately 8 days and 2 hours during the indicated time period.
Air Particulate	02/06/04	ZI-2	Due to air site electrical problems, gross beta data was not available for approximately 2 days and 21 hours during the indicated time period.
Air Particulate	03/03/04	ZI-2	Due to air site electrical problems, gross beta data was not available for approximately 11 days and 11 hours during the indicated time period.
Air Particulate	05/25/04	ZI-2	Due to air site electrical problems, gross beta data was not available for the indicated time period.

Table 3. Missing sample report for 2004.

Air Particulate	06/22/04	ZI-2	Due to air site electrical problems, gross beta data was not available for the indicated time period.
Air Particulate	08/10/04	ZI-2	Due to air site electrical problems, gross beta data was not available for approximately 6 days and 19 hours during the indicated time period.
Air Particulate	11/17/04	ZI-2	Due to air site electrical problems, gross beta data was not available for approximately 17 days and 15 hours during the indicated time period.
Air Particulate	12/21/04	ZI-2	Due to air site electrical problems, gross beta data was not available from approximately 11/14/04 21:00 until 12/09/04 11:00 during the indicated time period.
Air Gamma Isotopic	1st quarter	ZI 1,2	In late March and early April, SLH was in the process of upgrading from one software vendor to another for the qualitative and quantitative analysis of environmental samples. As a result some reported "less than" numbers for some analyses did not meet the required WI DHFS LLD.

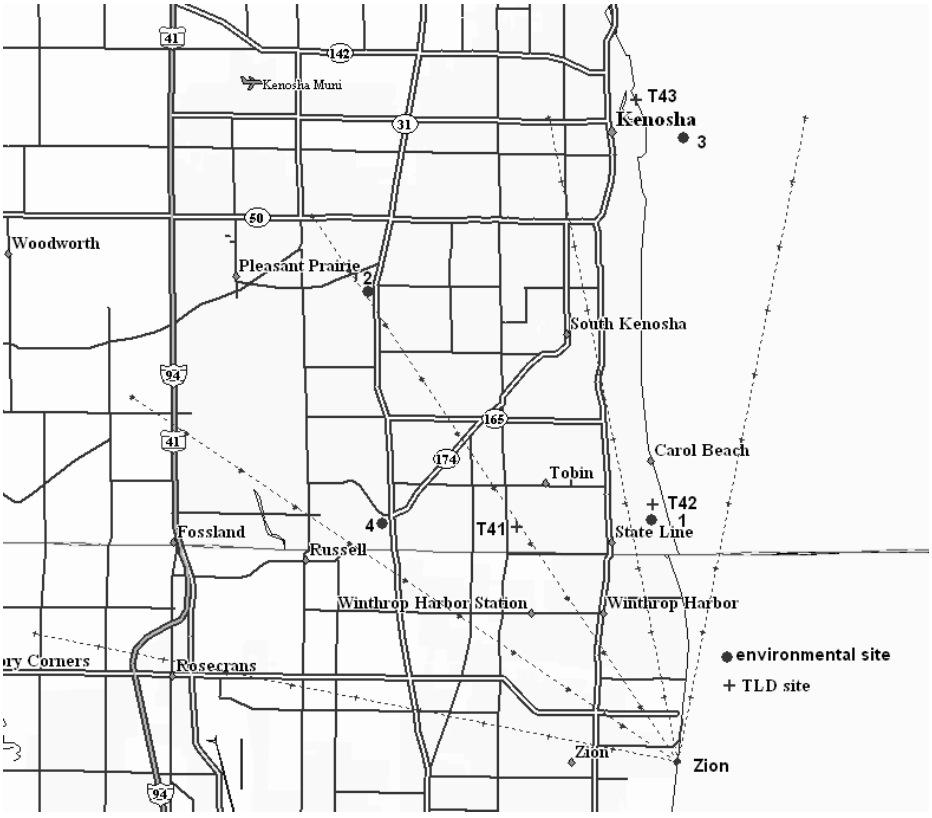

Figure 1. WI DHFS environmental monitoring sites for the Zion environmental monitoring program.

Results and Discussion

Air Particulate

A summary of reported activities by WI DHFS for air particulate samples is included in Table 4. Results from the individual sample analyses are listed in Tables 5 and 6.

From the quarterly gross beta activities listed in Table 5 it may be noted that there are no significant differences due to distance from the Zion nuclear facility. With no significant differences due to distance from the Zion nuclear facility an increase in gross beta activity attributable to the Zion plant operation is not evident.

The gamma isotopic analysis of the quarterly air particulate filter composites detected only small amounts of the radioisotopes listed in Table 6. Beryllium-7 (^{7}Be), detected in all composites, is constantly produced through nuclear reactions between cosmic rays and nuclei in the atmosphere and is detected in air composites from other areas of the state.

Influence by the Zion nuclear facility on air quality is not evident from air particulate analysis.

Ambient Gamma Radiation (TLDs)

A summary of reported activities by WI DHFS for ambient gamma radiation is included in Table 4. Results from the individual sample analyses are listed in Table 7.

Ambient gamma radiation (TLD) data for 2004 from the WI DHFS network was comparable for all sites. Significant differences in exposure were not noticed at different distances from the Zion nuclear facility. The average quarterly exposure from the three sites located within Wisconsin was 13.8 $\pm$ 1.8 milliroentgens. The average yearly exposure is at background levels and is comparable to other areas within Wisconsin.

Surface Water

A summary of reported activities by WI DHFS for surface water samples is included in Table 4. Results from the individual sample analyses are listed in Table 8.

The surface water samples showed no unusual activities and are at background levels comparable to previous years. From the gamma isotopic analysis, all radioisotopes were below their respective minimum detectable concentration. All reported activities for gross beta, gross alpha and tritium (^{3}H) are at background levels. The surface water samples uniformly show activities well below state or federal standards.

Vegetation

A summary of reported activities by WI DHFS for vegetation samples is included in Table 4. Results from the individual sample analyses are listed in Table 9.

Analysis of the vegetation samples showed no unusual activities. The gamma isotopic analysis detected only small amounts of the naturally occurring radioisotopes beryllium-7 (^{7}Be) and potassium-40 (^{40}K) listed in Table 4. All other radioisotopes were below their respective minimum detectable concentration.

Soil

A summary of reported activities by WI DHFS for soil samples is included in Table 4. Results from the individual sample analyses are listed in Table 9.

Analysis of the soil samples showed no unusual activities. The gamma isotopic analysis detected only small amounts of the radionuclides listed in Table 4. Potassium-40 (^{40}K) is a naturally occurring radioisotope. The reported activities for cesium-137 (^{137}Cs) were also detected in previous years and are attributable to fallout from previous atmospheric nuclear tests. Naturally occurring radioisotopes such as radium-226 (^{226}Ra), bismuth-214 (^{214}Bi), lead-214 (^{214}Pb), actinium-228 (^{228}Ac), bismuth-212 (^{212}Bi) and lead-212 (^{212}Pb) from the naturally occurring uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported.

Dose to an Average Individual

Federal regulations 10 CFR 20, 10 CFR 50 Appendix I and 40 CFR 190 restrict the annual exposure of the population from all parts of the nuclear fuel cycle, including nuclear power plants. Doses resulting from gaseous and liquid effluent releases from the Zion nuclear generating facilities are less than the limits as stated in these Federal regulations.

The WI DHFS limits for permissible levels of radiation exposure from external sources in unrestricted areas is defined in the Wis. Adm. Code section HFS 157.23. Doses resulting from gaseous and liquid effluent releases from the Zion nuclear generating facilities are less than the limits as stated in Wis. Adm. Code section HFS 157.23.

References

State of Wisconsin, Wisconsin Administrative Code, HFS 157.23

U.S. Environmental Protection Agency, Environmental Radiation Requirements for Normal Operations of Activities in the Uranium Fuel Cycle, EPA 520/4-76-016, 40 CFR Part 190, November 1976.

U.S. Nuclear Regulatory Commission, Title 10, Part 20.

U.S. Nuclear Regulatory Commission, Title 10, Part 50, Appendix I.

Table 4. Sample activity summary for the WI DHFS Zion environmental monitoring program for 2004.

Sample type (units)	MDC	Number of samples [a]	Analysis	Range
Air Particulate	0.003	45 / 45	Gross Beta	0.010 - 0.039
(pCi/m^3)			Gamma Isotopic	
	0.015	8 / 8	Be-7	0.043 - 0.061
	0.002	8 / 0	Mn-54	< 0.0005
	0.002	8 / 0	Co-58	< 0.0007
	0.010	8 / 0	Fe-59	< 0.0029
	0.005	8 / 0	Co-60	< 0.0005
	0.010	8 / 0	Zn-65	< 0.0010
	0.003	8 / 0	Nb-95	< 0.0020
	0.006	8 / 0	Zr-95	< 0.0013
	0.004	8 / 0	Ru-103	< 0.0013
	0.010	8 / 0	Ru-106	< 0.0038
	0.010	8 / 0	I-131	< 3.4
	0.002	8 / 0	Cs-134	< 0.0004
	0.002	8 / 0	Cs-137	< 0.0004
	0.020	8 / 0	Ba-140	< 0.062
	0.010	8 / 0	La-140	< 0.032
	0.004	8 / 0	Ce-141	< 0.0022
	0.006	8 / 0	Ce-144	< 0.0027
Ambient Gamma	1.0 [b]	12 / 12	Ambient Gamma	9.9 -16.1
(mR/Std Qtr)				
Vegetation	5000	4 / 0	Gross Alpha	< 2600
(pCi/kg wet)	5000	4 / 4	Gross Beta	5400 - 8100
			Gamma Isotopic	
	800	4 / 4	Be-7	630 - 2100
	1500	4 / 4	K-40	3700 - 5900
	90	4 / 0	Mn-54	< 80
	100	4 / 0	Co-58	< 70
	200	4 / 0	Fe-59	< 150
	100	4 / 0	Co-60	< 70
	250	4 / 0	Zn-65	< 180
	100	4 / 0	Nb-95	< 60
	200	4 / 0	Zr-95	< 130
	130	4 / 0	I-131	< 70
	80	4 / 0	Cs-134	< 60
	90	4 / 0	Cs-137	< 60
	350	4 / 0	Ba-140	< 230
	100	4 / 0	La-140	< 100

Table 4. Sample activity summary for the WI DHFS Zion environmental monitoring program for 2004.

Sample type (units)	MDC	Number of samples [a]	Analysis	Range
Surface Water	2.5	4 / 2	Gross Beta (Sol)	< 2.6 - 2.7
(pCi/liter)	2.5	4 / 0	Gross Beta (Insol)	< 2.5
	2.8	4 / 0	Gross Alpha (Sol)	< 2.0
	2.8	4 / 0	Gross Alpha (Insol)	< 1.5
	700	4 / 0	H-3	< 300
	4.0	4 / 0	Sr-89	< 0.7
	1.0	4 / 1	Sr-90	< 0.5 - 0.8
			Gamma Isotopic	
	13	4 / 0	Mn-54	< 12
	15	4 / 0	Co-58	< 11
	30	4 / 0	Fe-59	< 22
	15	4 / 0	Co-60	< 12
	30	4 / 0	Zn-65	< 24
	15	4 / 0	Nb-95	< 10
	30	4 / 0	Zr-95	< 19
	20	4 / 0	I-131	< 12
	13	4 / 0	Cs-134	< 12
	12	4 / 0	Cs-137	< 11
	60	4 / 0	Ba-140	< 40
	20	4 / 0	La-140	< 17
Soil	6000	4 / 4	Gross Beta	15000 - 32000
(pCi/kg dry)	10000	4 / 2	Gross Alpha	< 6000 - 10000
			Gamma Isotopic	
	700	4 / 4	K-40	7800 - 20700
	60	4 / 0	Mn-54	< 19
	90	4 / 0	Co-58	< 28
	600	4 / 0	Fe-59	< 90
	90	4 / 0	Co-60	< 20
	300	4 / 0	Zn-65	< 60
	100	4 / 0	Nb-95	< 70
	250	4 / 0	Zr-95	< 49
	80	4 / 0	Cs-134	< 40
	80	4 / 4	Cs-137	120 - 418

a - Number of analyses / number of analyses detected above the WI DHFS MDC.
b - 1.0 mR/TLD.

Table 5. WI DHFS air particulate analysis results from the Zion environmental monitoring program.

Measurements in units of pCi/m^3

ZI-1, Chiwaukee Prairie			ZI-2, Pleasant Prairie, Roger Prange Municipal Center		
Collection Date	**Volume m^3**	**Gross Beta**	**Collection Date**	**Volume m^3**	**Gross Beta**
01/08/04	579	0.031 +- 0.003	01/08/04	784	0.030 +- 0.002
01/22/04	809	0.027 +- 0.002	*a 01/22/04	450	0.039 +- 0.003
02/06/04	861	0.029 +- 0.002	*b 02/06/04	929	0.024 +- 0.002
02/18/04	663	0.029 +- 0.003	02/18/04	915	0.027 +- 0.002
03/03/04	766	0.026 +- 0.002	*c 03/03/04	189	0.036 +- 0.006
03/19/04	882	0.023 +- 0.002	03/19/04	1142	0.022 +- 0.002
04/02/04	870	0.014 +- 0.002	04/02/04	1042	0.015 +- 0.001
1st qtr mean +- s.d.		**0.026 +- 0.006**	**1st qtr mean +- s.d.**		**0.028 +- 0.008**
04/15/04	586	0.020 +- 0.002	04/15/04	938	0.013 +- 0.001
04/28/04	691	0.019 +- 0.002	04/28/04	938	0.015 +- 0.002
05/11/04	797	0.016 +- 0.002	05/11/04	931	0.015 +- 0.002
05/25/04	859	0.010 +- 0.001	*d 05/25/04		
06/09/04	902	0.012 +- 0.001	06/09/04	1053	0.013 +- 0.001
06/22/04	769	0.010 +- 0.002	*e 06/22/04		
2nd qtr mean +- s.d.		**0.015 +- 0.004**	**2nd qtr mean +- s.d.**		**0.014 +- 0.001**
07/08/04	923	0.014 +- 0.001	07/08/04	1072	0.013 +- 0.001
07/19/04	616	0.013 +- 0.002	07/19/04	698	0.014 +- 0.002
08/10/04	1209	0.019 +- 0.001	*f 08/10/04	964	0.024 +- 0.002
08/20/04	575	0.013 +- 0.002	08/20/04	643	0.017 +- 0.002
09/02/04	722	0.014 +- 0.002	09/02/04	821	0.016 +- 0.002
09/16/04	753	0.023 +- 0.002	09/16/04	855	0.023 +- 0.002
09/29/04	718	0.024 +- 0.002	09/29/04	817	0.023 +- 0.002
3rd qtr mean +- s.d.		**0.017 +- 0.005**	**3rd qtr mean +- s.d.**		**0.019 +- 0.005**
10/14/04	854	0.019 +- 0.002	10/14/04	985	0.020 +- 0.002
11/17/04	2009	0.021 +- 0.001	*g 11/17/04	1049	0.018 +- 0.002
11/30/04	775	0.026 +- 0.002			
12/21/04	1314	0.029 +- 0.002	*h 12/21/04	888	0.022 +- 0.002
4th qtr mean +- s.d.		**0.024 +- 0.004**	**4th qtr mean +- s.d.**		**0.020 +- 0.002**

Notes a – h: see Table 3. Missing sample report for 2004.

Table 6. WI DHFS gamma isotopic analysis results from the quarterly composites of air particulate filters collected for the WI DHFS Zion environmental monitoring program.

Measurements in units of pCi/m^3

	1st quarter	2nd quarter	3rd quarter	4th quarter
Chiwaukee Prairie				
ZI-1 (41000)				
Be-7	0.057 +- 0.003	0.060 +- 0.002	0.061 +- 0.003	0.052 +- 0.002
Mn-54	< 0.0003	< 0.0002	< 0.0005	< 0.0002
Co-58	< 0.0006	< 0.0002	< 0.0007	< 0.0003
Fe-59	< 0.0026	< 0.0005	< 0.0022	< 0.0008
Co-60	< 0.0003	< 0.0002	< 0.0005	< 0.0002
Zn-65	< 0.0007	< 0.0004	< 0.0010	< 0.0006
Nb-95	< 0.0019	< 0.0003	< 0.0013	< 0.0004
Zr-95	< 0.0012	< 0.0004	< 0.0013	< 0.0005
Ru-103	< 0.0012	< 0.0002	< 0.0012	< 0.0004
Ru-106	< 0.0024	< 0.0013	< 0.0038	< 0.0018
I-131	< 2.7000	< 0.0042	< 0.1000	< 0.0100
Cs-134	< 0.0003	< 0.0002	< 0.0004	< 0.0002
Cs-137	< 0.0002	< 0.0001	< 0.0004	< 0.0002
Ba-140	< 0.0476	< 0.0037	< 0.0420	< 0.0080
La-140	< 0.0195	< 0.0022	< 0.0160	< 0.0037
Ce-141	< 0.0019	< 0.0003	< 0.0022	< 0.0005
Ce-144	< 0.0009	< 0.0005	< 0.0027	< 0.0006
Pleasant Prairie; Roger Prange Municipal Center				
ZI-2 (43000)				
Be-7	0.046 +- 0.003	0.050 +- 0.002	0.059 +- 0.002	0.043 +- 0.002
Mn-54	< 0.0003	< 0.0002	< 0.0004	< 0.0004
Co-58	< 0.0006	< 0.0002	< 0.0005	< 0.0006
Fe-59	< 0.0029	< 0.0007	< 0.0018	< 0.0013
Co-60	< 0.0003	< 0.0002	< 0.0004	< 0.0005
Zn-65	< 0.0007	< 0.0004	< 0.0008	< 0.0010
Nb-95	< 0.0020	< 0.0003	< 0.0010	< 0.0008
Zr-95	< 0.0013	< 0.0004	< 0.0010	< 0.0010
Ru-103	< 0.0013	< 0.0003	< 0.0008	< 0.0006
Ru-106	< 0.0024	< 0.0015	< 0.0030	< 0.0030
I-131	< 3.4000	< 0.0046	< 0.0600	< 0.0100
Cs-134	< 0.0003	< 0.0002	< 0.0003	< 0.0004
Cs-137	< 0.0002	< 0.0002	< 0.0003	< 0.0004
Ba-140	< 0.0621	< 0.0046	< 0.0300	< 0.0100
La-140	< 0.0324	< 0.0026	< 0.0130	< 0.0053
Ce-141	< 0.0021	< 0.0003	< 0.0010	< 0.0008
Ce-144	< 0.0010	< 0.0005	< 0.0012	< 0.0012

Radioisotopes other than those reported were not detected.

Table 7. WI DHFS TLD network for Zion.

			1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
	Date Placed:		01/06/04	04/01/04	07/06/04	10/05/04
	Date Removed:		04/01/04	07/06/04	10/05/04	01/06/05
	Days in the Field:		86	96	91	93
Location:			mR / Standard Quarter			
T41	4.7	NW	15.3 +- 3.1	13.0 +- 2.6	16.1 +- 3.2	15.0 +- 3.0
T42	3.8	N	12.7 +- 2.5	11.2 +- 2.2	13.0 +- 2.6	12.8 +- 2.6
T43	10.1	N	12.5 +- 2.5	9.9 +- 2.0	12.3 +- 2.5	11.7 +- 2.3

Table 8. WI DHFS analysis results of surface water samples collected for the WI DHFS Zion environmental monitoring program.

Measurements in units of pCi/liter

ZI-3

Collection date	**01/20/04**	**04/13/04**	**07/20/04**	**10/14/04**
Gross Alpha-Sol	< 2.0	< 1.8	< 1.8	< 1.9
Gross Beta-Sol	2.4 +- 1.3	< 2.4	2.7 +- 1.6	< 2.6
Gross Alpha-Insol	< 1.5	< 1.3	< 1.2	< 1.2
Gross Beta-Insol	< 2.5	< 2.4	< 2.4	< 2.5
H-3	< 300	< 300	< 300	< 300
Sr-89	< 0.4	< 0.6	< 0.7	< 0.4
Sr-90	< 0.5	< 0.4	0.8 +- 0.4	< 0.3
Gamma isotopic				
Mn-54	< 7	< 10	< 7	< 12
Co-58	< 6	< 9	< 7	< 11
Fe-59	< 21	< 18	< 13	< 22
Co-60	< 8	< 10	< 7	< 12
Zn-65	< 15	< 20	< 15	< 24
Nb-95	< 8	< 9	< 7	< 10
Zr-95	< 13	< 17	< 13	< 19
I-131	< 8	< 12	< 11	< 12
Cs-134	< 7	< 10	< 7	< 12
Cs-137	< 7	< 10	< 8	< 11
Ba-140	< 25	< 36	< 31	< 40
La-140	< 12	< 12	< 9	< 17

Radioisotopes other than those reported were not detected.

Table 9. WI DHFS analysis results for vegetation and soil samples collected for the WI DHFS Zion environmental monitoring program.

Measurements in units of pCi/kilogram (wet)

Collection	**05/11/04**	**05/11/04**	**09/14/04**	**09/14/04**
Type	**Vegetation**	**Vegetation**	**Vegetation**	**Vegetation**
Location	**ZI-1**	**ZI-4**	**ZI-1**	**ZI-4**
Analysis				
Gross Alpha	< 1500	< 1400	< 2600	< 1900
Gross Beta	5400 +- 1100	6300 +- 1100	6000 +- 2000	8100 +- 1400
Gamma isotopic				
Be-7	1800 +- 200	1100 +- 200	2100 +- 200	630 +- 150
K-40	3700 +- 300	4700 +- 400	4800 +- 300	5900 +- 400
Mn-54	< 70	< 80	< 60	< 70
Co-58	< 60	< 70	< 60	< 60
Fe-59	< 120	< 150	< 110	< 140
Co-60	< 60	< 60	< 60	< 70
Zn-65	< 160	< 180	< 120	< 150
Nb-95	< 49	< 50	< 48	< 60
Zr-95	< 90	< 130	< 100	< 100
I-131	< 60	< 60	< 70	< 60
Cs-134	< 43	< 60	< 53	< 60
Cs-137	< 60	< 60	< 60	< 60
Ba-140	< 220	< 220	< 230	< 210
La-140	< 70	< 100	< 70	< 70

Measurements in units of pCi/kilogram (dry)

Collection	**05/11/04**	**05/11/04**	**09/14/04**	**09/14/04**
Type	**Soil**	**Soil**	**Soil**	**Soil**
Location	**ZI-1**	**ZI-4**	**ZI-1**	**ZI-4**
Analysis				
gross alpha	< 6000	8000 +- 5000	< 6000	10000 +- 6000
gross beta	15000 +- 4000	27000 +- 5000	16000 +- 4000	32000 +- 5000
Gamma isotopic				
K-40	7800 +- 200	16200 +- 500	9500 +- 300	20700 +- 600
Mn-54	< 9	< 17	< 13	< 19
Co-58	< 14	< 28	< 13	< 18
Fe-59	< 49	< 90	< 30	< 42
Co-60	< 9	< 16	< 15	< 20
Zn-65	< 27	< 60	< 36	< 60
Nb-95	< 34	< 70	< 14	< 18
Zr-95	< 27	< 49	< 22	< 31
Cs-134	< 10	< 22	< 18	< 40
Cs-137	320 +- 10	120 +- 20	418 +- 11	131 +- 8

Naturally occurring radioisotopes such as radium-226 (^{226}Ra), bismuth-214 (^{214}Bi), lead-214 (^{214}Pb), actinium-228 (^{228}Ac), bismuth-212 (^{212}Bi) and lead-212 (^{212}Pb) from the naturally occurring uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported.

Radioisotopes other than those reported were not detected.